Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

2T22
p.2

COMMERCIAL USES AND VOLUME OF HAWAIIAN TREE FERN

Robert E. Nelson
E.M. Hornibrook

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
1 4 1963
CURRENT SERIAL RECORDS

U.S.D.A., NAL
AUG 2 8 2008
CATALOGING PREP

1962
Technical Paper 73

Pacific Southwest Forest and Range
Experiment Station - Berkeley, California
Forest Service - U.S. Department of Agriculture

COMMERCIAL USES AND VOLUME

OF

HAWAIIAN TREE FERN

By

Robert E. Nelson and E. M. Hornibrook

Contents | Page

Species and Occurrence- 1
Definitions - 4
Estimating Volume - 5
Starch Core - 6
Yield from Fern Logs- 7
Literature Cited- 10

Technical Paper No. 73 1962

U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE
PACIFIC SOUTHWEST FOREST AND RANGE EXPERIMENT STATION
Berkeley, California
in cooperation with
FORESTRY DIVISION, DEPARTMENT OF LAND AND NATURAL RESOURCES,
STATE OF HAWAII

COMMERCIAL USES AND VOLUME
OF HAWAIIAN TREE FERN

By

Robert E. Nelson, Honolulu
and
E. M. Hornibrook, Berkeley

Tree ferns of the rain forests of Hawaii are the source of raw material for a small but thriving manufacturing industry. The trunk is an interwoven mass of aerial roots extending from the base of each frond to the ground. It has desirable characteristics for many uses. It is firm and can be sawed into boards, short poles, or blocks. Sawed surfaces have an attractive texture. Like peat moss, the fibrous material absorbs a large amount of water and is relatively resistant to decay. Plants root readily in this material.

Tree-fern products are marketed primarily as plant supports--short poles to support potted climbing vines--decorative wall panelling on which clinging vines can grow, plant pots and cubes, display bases, and organic fiber. The loose or chipped fibers are an excellent potting material for many plants. Vanda orchids are grown commercially on short sections of logs. Logs of exceptional quality are carved into decorative statues.

Producers of tree fern products have established markets on the mainland as well as in Hawaii although the industry is little more than 10 years old (4,5). In 1960 more than 100,000 cubic feet of fern were harvested and processed. The permanency of the industry and its potential for growth depend on the volume available and on the future supply as determined by growth and depletion. This report presents a volume table and other information which will help foresters, harvesters, and processors to estimate the present and future supply.

Species and Occurrence

Tree ferns grow in the rain forests of all the main islands, but the only commercially operable stands occur on the island of Hawaii (3). Here three species develop trunks of sufficient size to be harvested:

> *Cibotium menziesii* (hapu'u ii) is the largest and most valuable tree fern for milling. Some attain a height of more than 40 feet and diameters greater than 4 feet.
>
> *C. chamissoi* (hapu'u) is probably the most common and is valued chiefly for chips and fiber. Trunks of this species are usually of small diameter, so it is less valuable for sawlogs.
>
> *C. glaucum* (hapu'u) is not common but is harvested and used in the round to make large plant-support poles.

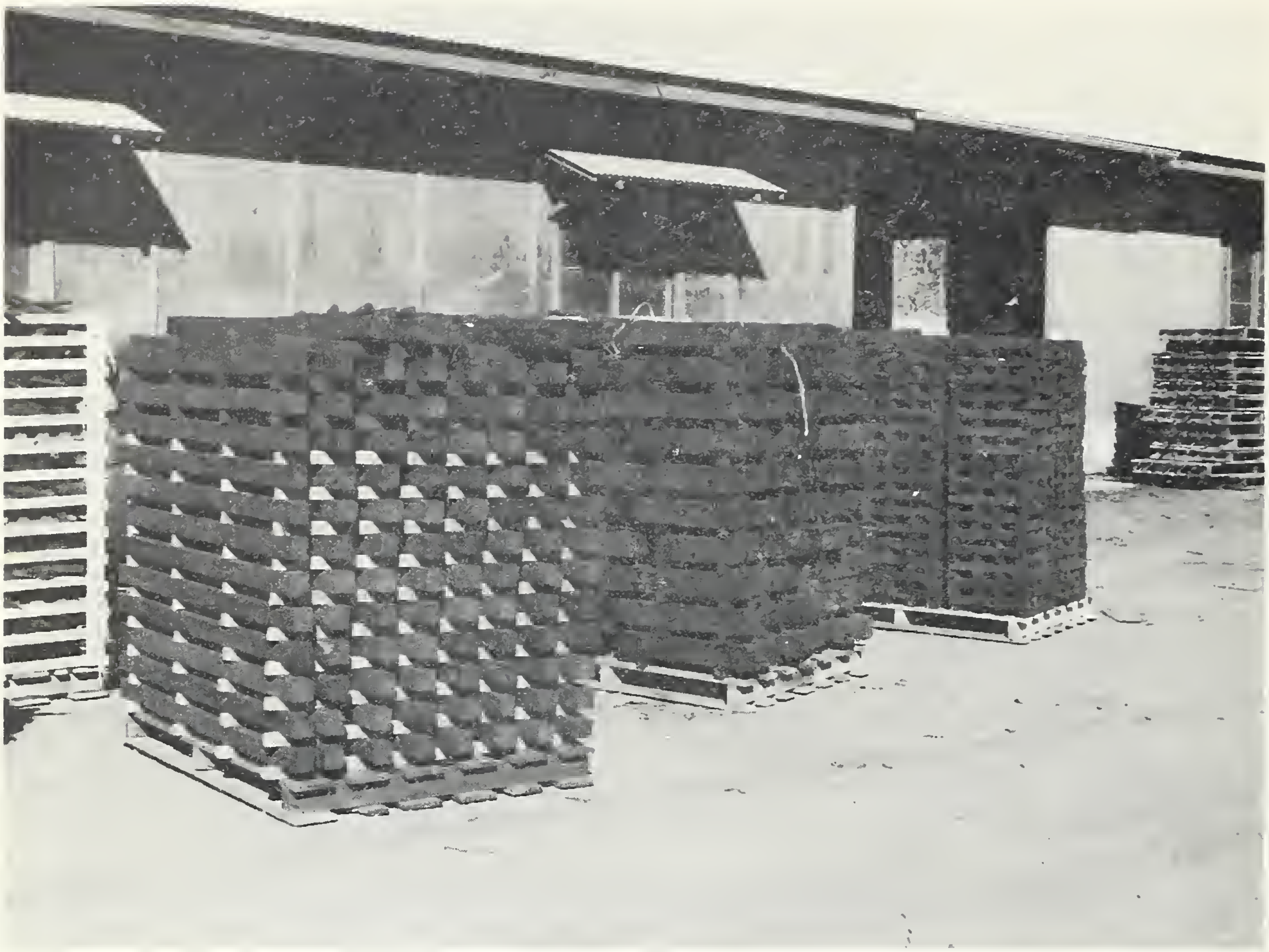

Figure 1.--Planter poles are high value products milled from tree fern logs.

A survey made in 1950 and 1951 by the Hawaii Forestry Division indicated that more than 225,000 acres of land on the island of Hawaii supported tree fern (6). This estimate included lands in Hawaii National Park and other lands where policy prevents harvesting, but there was "an area of 151,500 acres where harvesting would be permissible and feasible." The 107,000 acres of land under State control had an estimated 852,000 cords of merchantable fern plus 486,000 cords of pulp fern. This estimate would indicate an average yield per acre of about 850 cubic feet of merchantable fern logs plus 500 cubic feet of pulp fern. (Original data indicate that conversion ratio varied from about 90 cubic feet/cord for small material to over 120 cubic feet/cord for larger logs.)

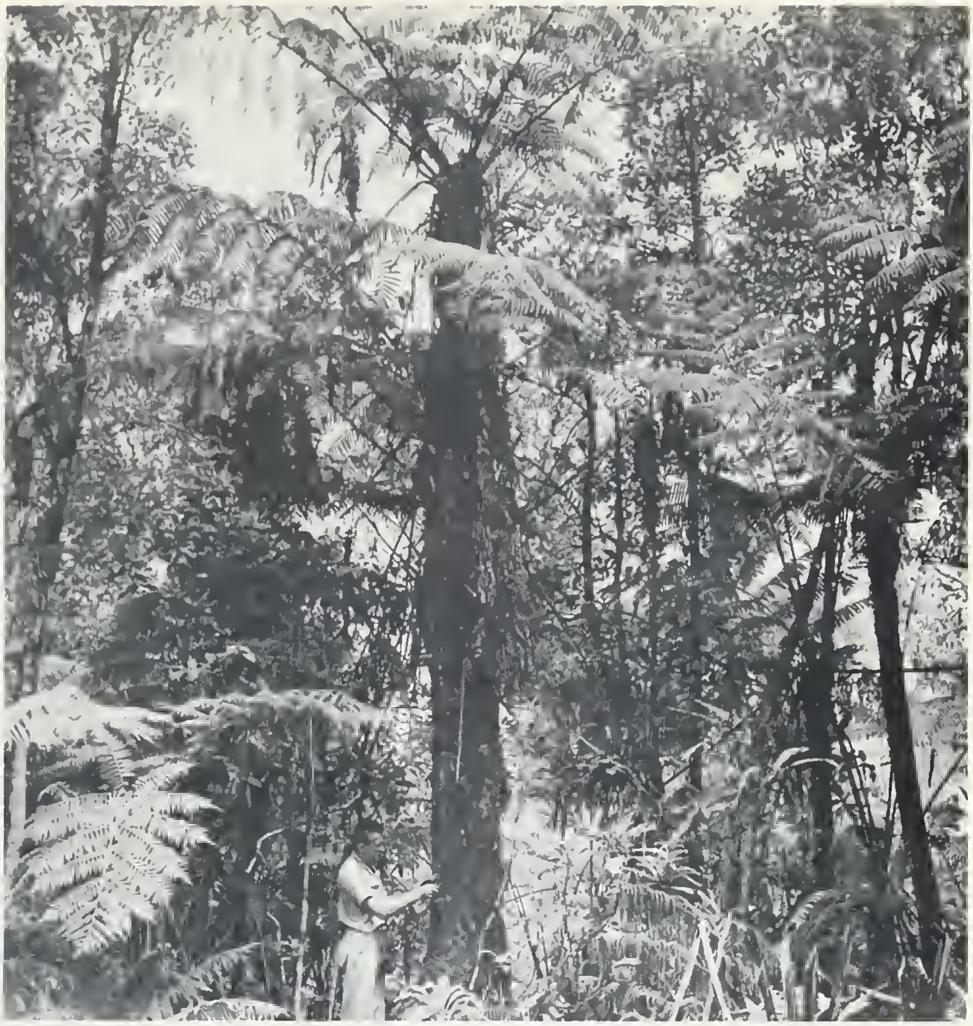

Figure 2.--*Cibotium menziesii* is most abundant in the rain forests at lower elevations.

More recent but fragmentary information indicates that the 1950-51 estimates of per acre volumes of merchantable fern may be high. Experienced loggers report that some good areas yield 700 to 800 cubic feet of merchantable logs per acre. During a clearing operation in the Waiakea Forest Reserve in 1960 it was reported that a total of 5,839 cubic feet of merchantable fern logs were harvested from 33 acres--176 cubic feet per acre.[1]

Ripperton (2) reported that the average annual vertical growth of tree fern trunks is 4.35 inches. He did not report diameter growth or volume increment of the fibrous trunk.

Additional information on the tree fern resource is being obtained as part of the work of the timber resource survey.[2] At sample plot locations in the forests where timber trees are measured, tree ferns are also measured. These data will provide a basis for estimating volume per acre at the plot location. Although the plot data will provide valuable information, the timber resource survey was not designed to provide estimates of fern volume at the same accuracy as timber volume. Remeasurement of permanent plots after a period of years will provide data on growth, and accumulated data will make it possible to refine fern volume estimates.

---

[1] Communication from L. W. Bryan, Deputy State Forester.

[2] A survey of the timber resource in Hawaii being conducted by the Hawaii Forestry Division in cooperation with the Pacific Southwest Forest and Range Experiment Station, U. S. Forest Service.

Definitions

Before measuring tree ferns it was necessary to determine utilization practices and define terms. Foresters working on the timber resource survey consulted with district foresters, mill operators, and harvesters and established the following terms and definitions:

Base diameter - The diameter of the trunk 1 foot above the ground or at the point on the stem where excessive basal taper ends.

Merchantable length - The length from the stump (essentially ground level) to a point 3 feet below the base of the first live frond. Tree ferns are seldom cut unless the trunk will yield at least one log 4 feet long with a minimum diameter of about 8 inches.

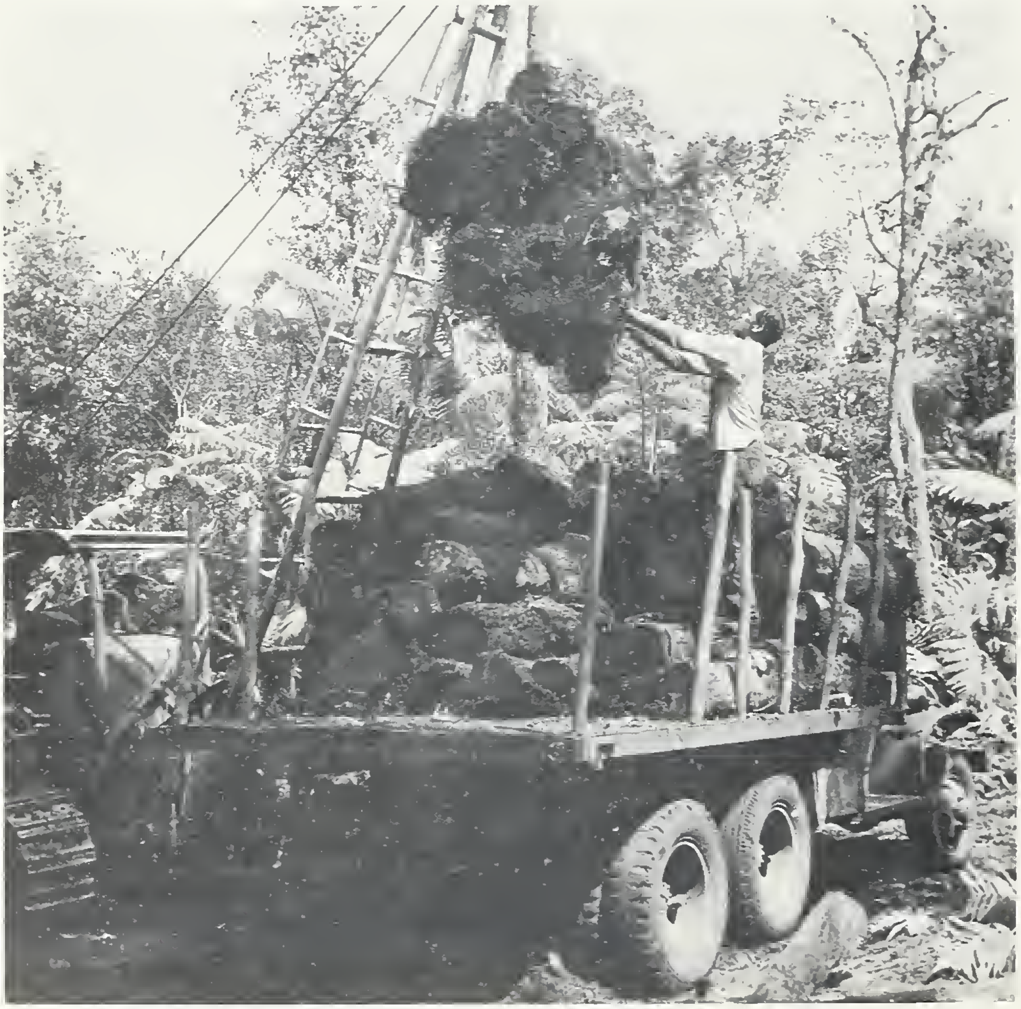

Figure 3.--Some tree fern logging operations are highly mechanized.

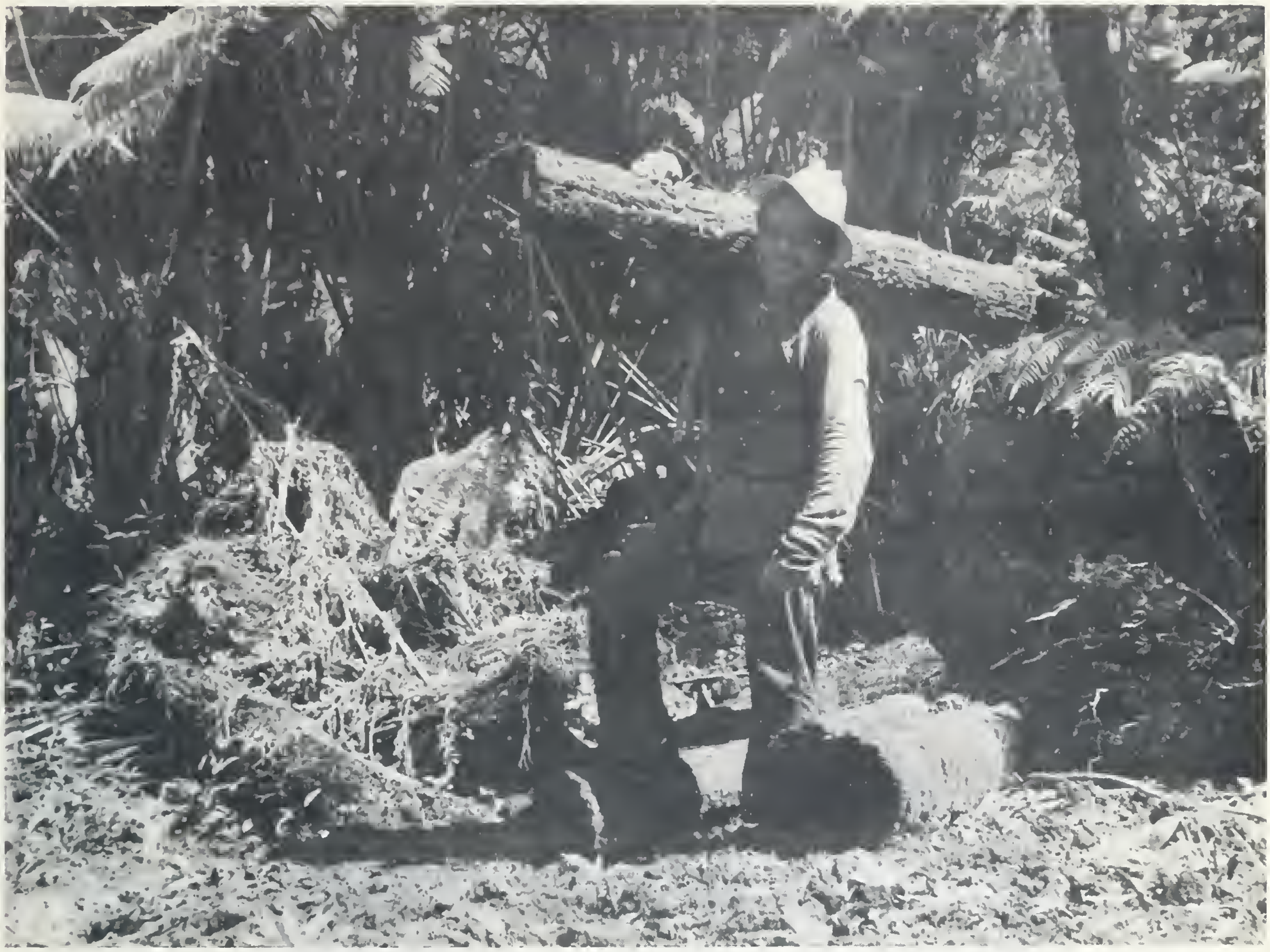

Figure 4.--Small logs are often cut with a cane knife and shoulder carried to a haul road.

Estimating Volume

Satisfactory cruise estimates of the total volume in a large number of tree ferns can be made by use of a volume table constructed from detailed measurements of a representative sample of stems. At forest survey sample plots tree ferns were tallied by species, base diameter, and merchantable length. Conversion of these field measurements to gross cubic-foot volumes is done by use of table 1, prepared from detailed measurements of 131 tree ferns from several localities on the island of Hawaii.

Starch Core

The mass of fibrous roots forming the tree trunk surrounds a central core of starch which is unsuited for sawed products. The starch core is irregular in cross section and is surrounded by hard tissue. In milling, the practice is to box out a core section about 1 inch larger than the core diameter to avoid leaving pits and knobs of core and frond tissue in the sawed products. The material contained in the boxed-out section is pulverized and marketed as fiber.

Core volume makes up a significant percentage of gross volume, especially in logs of small diameter and should be deducted in estimating net volume of high grade merchantable material. Tree ferns grown from "seedlings" usually have very small cores at the butt; however, the core tapers and increases in size up the stem until it attains normal dimensions. In contrast, many tree ferns which have regrown from the tips of fallen trees have relatively large diameter cores from base to top (2, 4). In some trunks the starch core has decayed at the lower or butt end and fibrous roots fill the core space.

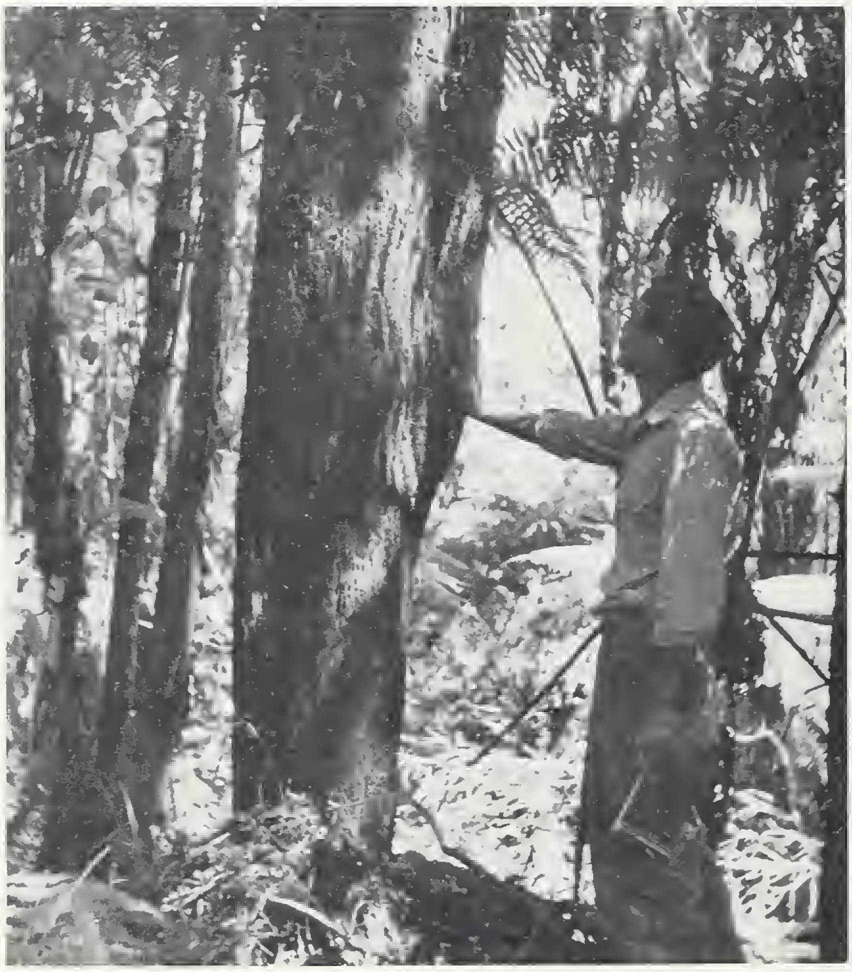

Figure 5.--Trunks of tree ferns are often of irregular form and taper.

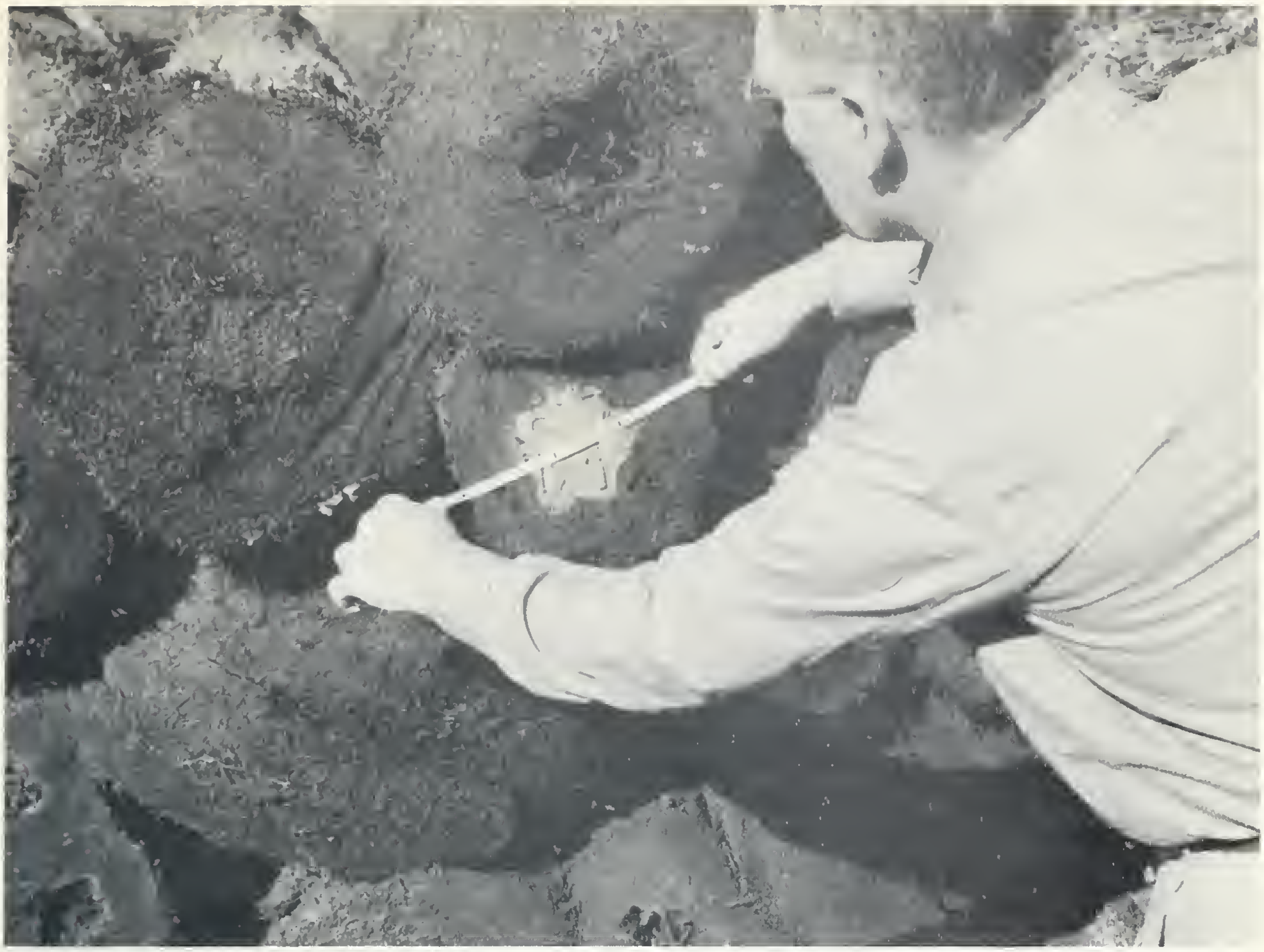

Figure 6.--Most tree fern logs have a central core of non-fibrous material.

To determine the volume of boxed-out core material, measurements were made of a sample of 80 fern logs, primarily C. menziesii. Log diameters and core diameters were measured. Nine of these logs had multiple cores. Analysis of the data showed no significant relationship between log diameter and core diameter. The average core diameter was 3.5 inches. The largest core was 5.0 inches in diameter; some logs had no core, i.e. the core had decayed and was replaced with roots. The average cross section area of the boxed-out core, including multiple cores, is 0.15 square feet. Thus, log length in feet x 0.15 equals core volume in cubic feet. The estimated net volume of merchantable fiber material in tree ferns is obtained by deducting the calculated volume of core material from gross volume of tree ferns given in table 1.

Yield From Fern Logs

Only a limited amount of information is available regarding the total yield of marketable products that can be recovered from processed fern logs. For example; one truck load of fern logs showed a yield of 44 percent of the gross log volume in sawed products (planter poles), and an additional amount of fern fiber.[3] This load of logs had a total gross scaled volume of 566 cubic feet; it cut out 250 cubic feet of planter poles and 162 cubic feet of fern fiber; 102 cubic feet was culled for starch core, leaving a remainder of 52 cubic feet unaccounted for. This remainder probably consisted of sawdust and other fine material as well as lost or unidentified pieces.

---

[3] Correspondence from Myron L. Wold, Hawaiian Fern-Wood, Ltd., Hilo, Hawaii.

It is evident that additional mill scale studies are needed to determine average net yields of various types and sizes of sawed products that logs of different sizes and fern species will yield. Such studies should also provide information regarding production costs, yield values, and minimum log size that can be profitably milled.

Table 1.-- Gross cubic-foot volume of Hawaiian tree fern, by base diameter and merchantable length

Base diameter (inches)	Merchantable length (feet)														Basis, No. of trees
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	
	Cubic feet														
6	0.5	1.2	1.7	2.0	2.2										1
7	0.7	1.5	2.2	2.7	3.1	3.3									6
8	0.8	1.9	2.8	3.5	4.0	4.4	4.6								5
9	1.0	2.2	3.3	4.2	4.9	5.5	5.9								5
10	1.2	2.6	3.8	4.9	5.9	6.6	7.2	7.6	7.9						8
11	1.3	3.0	4.4	5.7	6.8	7.7	8.5	9.1	9.6	9.9					14
12	1.5	3.3	5.0	6.4	7.7	8.8	9.8	10.6	11.3	11.7	12.1				9
13	1.7	3.7	5.5	7.2	8.6	10.0	11.1	12.1	13.0	13.6	14.1				9
14	1.9	4.1	6.1	7.9	9.6	11.1	12.4	13.6	14.6	15.5	16.2				12
15	2.1	4.5	6.7	8.7	10.5	12.2	13.8	15.1	16.3	17.4	18.3				11
16		4.9	7.2	9.4	11.5	13.4	15.1	16.7	18.0	19.3	20.3	21.2			10
17		5.3	7.8	10.2	12.5	14.5	16.4	18.2	19.7	21.2	22.4	23.5			9
18		5.7	8.4	11.0	13.4	15.7	17.8	19.7	21.5	23.1	24.5	25.8	26.9		5
19		6.1	9.0	11.7	14.4	16.8	19.1	21.2	23.2	25.0	26.6	28.1	29.4		7
20		6.5	9.6	12.5	15.4	18.0	20.5	22.8	24.9	26.9	28.7	30.3	31.8	33.2	6
21		6.9	10.2	13.4	16.4	19.2	21.8	24.3	26.6	28.8	30.8	32.6	34.3	35.8	2
22		7.4	10.8	14.2	17.4	20.3	23.2	25.9	28.4	30.7	32.9	34.9	36.8	38.5	4
23		7.8	11.5	15.0	18.3	21.5	24.6	27.4	30.1	32.7	35.0	37.2	39.3	41.2	2
24			12.1	15.8	19.3	22.7	25.9	29.0	31.9	34.6	37.1	39.6	41.8	43.9	2
25			12.7	16.6	20.3	23.9	27.3	30.6	33.6	36.5	39.3	41.9	44.3	46.5	1
26			13.4	17.4	21.4	25.1	28.7	32.1	35.4	38.5	41.4	44.2	46.8	49.2	1
27			14.0	18.3	22.4	26.3	30.1	33.7	37.2	40.4	43.6	46.5	49.3	51.9	1
28			14.6	19.1	23.4	27.5	31.5	35.3	38.9	42.4	45.7	48.9	51.8	54.6	0
29				20.0	24.4	28.7	32.9	36.9	40.7	44.4	47.9	51.2	54.3	57.4	0
30				20.8	25.5	30.0	34.3	38.5	42.5	46.3	50.0	53.5	56.9	60.1	1
31						31.2	35.7	40.1	44.3	48.3	52.2	55.9	59.4	62.8	0
32						32.4	37.1	41.7	46.1	50.3	54.3	58.2	62.0	65.5	0
Number of trees	11	13	12	18	19	22	18	10	6	0	2	0	0	0	131

Block indicates extent of basic data.

Base diameter: Diameter of the trunk 1 foot above the ground or at the point on the stem where excessive basal taper ends.

Merchantable length: From stump to 3 feet below the base of the first live frond.

Stump height: Essentially ground level.

The equation from which the table volumes were obtained is as follows:

$$\text{Volume} = 0.06867 \text{ (base dia.)} - 0.10395 \text{ (merch. length)} + 0.09354 \text{ (base dia.)(merch. length)} + 0.00284 \text{ (base dia.)}^2 - 0.02051 \text{ (merch. length)}^2.$$

Average deviation of individual tree volumes from values estimated by the equation was 18.9 percent.

Aggregate difference: Estimated values 0.5 percent high.

Literature Cited

1. Hubbard, Douglass H.
   1952. Ferns of Hawaii National Park. Hawaii Nature Notes, Vol. V, No. 1, 40 pp., illus.

2. Ripperton, J. C.
   1942. The Hawaiian tree fern as a commercial source of starch. Hawaii Agr. Expt. Sta. Bul. 53, 16 pp., illus.

3. Rock, Joseph F.
   1913. The indigenous trees of the Hawaiian islands. Honolulu, Hawaii. 518 pp., illus.

4. Wold, Myron L.
   Undated. Tree ferns of Hawaii--a non-technical description of the three main species, their characteristics and uses. Hawaiian Fern-Wood, Ltd., Hilo, Hawaii. 6 pp.

5. Pierce, Howard.
   1958. Hawaiian Fern-Wood, Ltd. Hilo Tribune-Herald. Advertising Sup. Sept. 20. 12 pp., illus.

6. Board of Commissioners of Agriculture and Forestry of the Territory
   1952. of Hawaii, 1952. Inventory of forest products. Biennial Report, period ending June 30, 1952.

Nelson, Robert E., and Hornibrook, E. M.
1962. Commercial uses and volume of Hawaiian tree fern. U.S. Forest Serv. Pacific SW. Forest & Range Expt. Sta. Tech. Paper 73, 10 pp., illus.

Several species of tree fern grow to large sizes on the Hawaiian islands. Roots, growing from the base of fronds, develop a trunk of fibrous material that has commercial uses. Harvesting and processing tree fern is the basis of a small, thriving industry. A volume table for estimating the cubic contents of individual ferns is given together with preliminary information on the abundance, concentration, and total volume of this natural resource.

Nelson, Robert E., and Hornibrook, E. M.
1962. Commercial uses and volume of Hawaiian tree fern. U.S. Forest Serv. Pacific SW. Forest & Range Expt. Sta. Tech. Paper 73, 10 pp., illus.

Several species of tree fern grow to large sizes on the Hawaiian islands. Roots, growing from the base of fronds, develop a trunk of fibrous material that has commercial uses. Harvesting and processing tree fern is the basis of a small, thriving industry. A volume table for estimating the cubic contents of individual ferns is given together with preliminary information on the abundance, concentration, and total volume of this natural resource.

Nelson, Robert E., and Hornibrook, E. M.
1962. Commercial uses and volume of Hawaiian tree fern. U.S. Forest Serv. Pacific SW. Forest & Range Expt. Sta. Tech. Paper 73, 10 pp., illus.

Several species of tree fern grow to large sizes on the Hawaiian islands. Roots, growing from the base of fronds, develop a trunk of fibrous material that has commercial uses. Harvesting and processing tree fern is the basis of a small, thriving industry. A volume table for estimating the cubic contents of individual ferns is given together with preliminary information on the abundance, concentration, and total volume of this natural resource.

* NATIONAL AGRICULTURAL LIBRARY
1022501026